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The Commonwealth of Massachusetts

Department of Labor and Industries

DIVISION OF OCCUPATIONAL HYGIENE

OCCUPATIONAL HEALTH HAZARDS IN MASSACHUSETTS INDUSTRIES

III. SHOE MANUFACTURE

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FOREWORD

The survey described in the following report is one of a series of industrial health studies conducted by the Division of Occupational Hygiene of the Massachusetts Department of Labor and Industries, in co-operation with the Works Progress Administration, as part of the Industrial Chemical Survey Project, W. P. A. No. 65-14-6060. This survey was supervised by Hervey B. Elkins, chemist of the division. The purpose of this work is to secure, as a basis for constructive preventive effort, knowledge of the extent and manner of use of the more important potentially hazardous chemicals in the industries of the Commonwealth. The wholehearted assistance of the establishments visited is gratefully acknowledged.

THE SERVICES OF THE DIVISION OF OCCUPATIONAL HYGIENE ARE AVAILABLE ON REQUEST IN CONNECTION WITH MATTERS PERTAINING TO THE HEALTH OF INDUSTRIAL AND MERCANTILE WORKERS.

OCCUPATIONAL HEALTH HAZARDS IN MASSACHUSETTS INDUSTRIES

III. SHOE MANUFACTURE

In this survey forty-nine establishments employing 18,050 wage earners, 7,970 of whom were females, were visited. These factories may be grouped according to the type of shoe manufactured, as follows:

TABLE I.—SHOE FACTORIES VISITED, BY TYPE OF SHOE

TYPE OF SHOE	NUMBER OF FACTORIES VISITED			
	Women's Shoes	Men's Shoes	Other	TOTAL
Cemented	12			12
McKays	12	4		16
Welts	3	14		17
Other*			4	4
Total	27	18	4	49

*Slippers, stitchdowns.

Another classification of interest is as to grade of product:

TABLE II.—SHOE FACTORIES VISITED, BY GRADE OF SHOE

	NUMBER OF FACTORIES VISITED	
	Men's Shoes	Women's Shoes
High Grade	7	2
Medium Grade	7	15
Low Grade	4	10

Twenty-nine per cent of the establishments visited employed a person designated as a safety engineer; fifteen per cent had a safety council. Twelve per cent engaged the part-time services of a physician; eighty-three per cent had a female employee rated as capable of serving as a nurse. In only one factory were the employees subjected to any form of physical examination, this being a pre-employment examination given by the nurse.

Chemicals Used in Shoe Manufacture.—The most important chemical products found in shoe manufacture may be classified as cements, stains, finishes, bleaches and cleaners, the use of nearly all of which is on the increase. In the analysis of over 100 samples of such products collected in the course of the survey, no attempt was made to determine the exact formula of the various materials, but the important volatile constituents were identified and their respective quantities estimated. Of the sixteen included in the nineteen hazards listed in Table VI, all but ammonia and oxalic acid are volatile organic solvents.

Benzol.—The most important chemical health hazard in the shoe industry was found to be benzol. Its chief use is in rubber cements. Although it has been largely displaced by naphtha, and despite the fact that rubber cements have been partly replaced by latex cements, products containing benzol are used in significant quantities in an appreciable proportion of shoe factories. The various materials found to contain benzol, with the number of factories using them, are shown in Table III. Some of these items, notably crepe sole cements and white cleaners, are used only in certain seasons.

TABLE III.—MATERIALS FOUND TO CONTAIN BENZOL

PRODUCT CONTAINING BENZOL	Number of Factories
Rubber heel cement	8
Breasting cement	5
Crepe sole cement	5
Channel cement	4
Sole cement	4
Liquid benzol	3
Stain	1
White cleaner	1
Total	31

If the quantity of benzol is taken into consideration, the most important benzol-containing materials are rubber heel cements and breasting cements.

In Figure 1, showing the relationship between the amount of benzol used and the type and quality of shoes manufactured, it will be seen that relatively more benzol is used in making high grade shoes (welts) than in other types. Nearly ninety per cent of the high grade shoe factories used benzol in some form, as compared with only fourteen per cent of the factories making cheap types, chiefly McKays. About half the factories making medium grade shoes used products containing benzol.

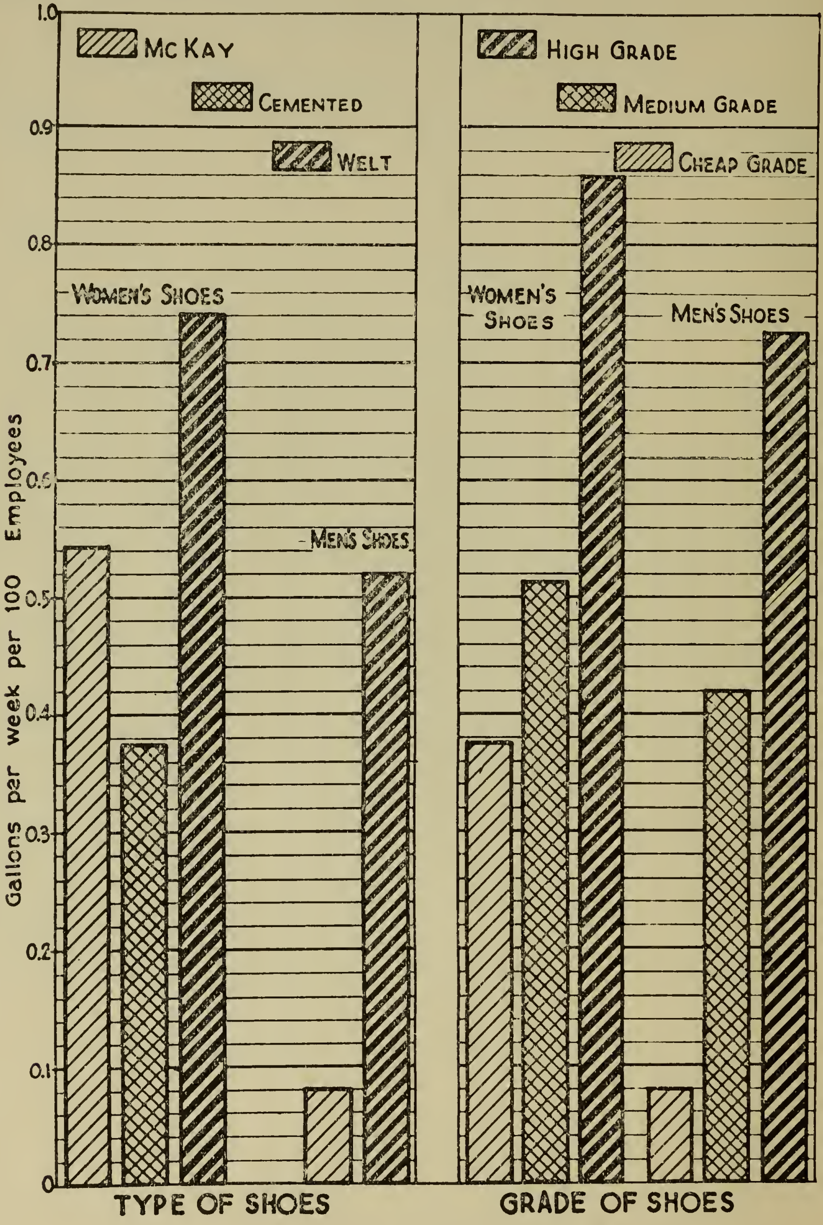

Figure 1. Consumption of Benzol in Shoe Manufacture

In order to measure the degree of exposure to benzol vapor, tests were made in the vicinity of ten different individual operations involving six processes using benzol. The results of these tests are shown in Table IV.

TABLE IV.—AIR ANALYSES FOR BENZOL VAPORS

OPERATION	Product — Per cent Benzol in Solvent	Amount Used	PERSONS EXPOSED		Number of Analyses	CONCENTRATION OF BENZOL VAPOR (Parts per million)			Ventilation
			Male	Female		Max.	Min.	Avg.	
Breasting	Breasting cement (50% benzol)	2½ gal. per day	8 (indirectly)	3	5	720	120	355	Natural
Breasting	Breasting cement (55% benzol)	6 gal. per day	10		3	230	12	110	Natural
Cementing Channels .	Channel cement (75% benzol)	2/3 gal. per day	1		2	70	55	60	Natural
Cementing Bottoms .	Sole cement (80% benzol)	2 gal. per day	1		2	385	350	365	Natural
Cementing Soles . .	Rubber sole cement	1½ gal. per day	1		1	200		200	Natural
Cementing Soles . .	Sole cement (100% benzol)	2 gal. per day	1		1	30		30	Local Exhaust (Down Draft)
Cementing Rubber Heels	Rubber heel cement			1	2	20	13	16	Local Exhaust (Down Draft)
Cementing Rubber Heels	Rubber heel cement (50% benzol)	2 gal. per day	2		2	455	415	435	Natural
Cementing Rubber Heels	Rubber heel cement (95% benzol)	2 gal. per day		1	2	35	12	23	Local Exhaust (Down Draft)
Treeing	Cleaner and uniformer (24% benzol)	1 gal. per day	6		3	50	25	35	Natural

The maximum allowable concentration of benzol vapor for continued exposure is 75 parts per million.

Methanol was used more widely and one plant reported having had trouble with it. Carbon bisulfide, the most toxic solvent found in the survey, was used in oil spot removers in seven factories, as well as in one special rubber cement. Toluol and trichloroethylene were used in small quantities. Orthodichlorbenzene was apparently substituted for nitrobenzene in one product. The latter was nowhere found.

Of the six processes involving the use of benzol cements and not equipped with blower systems, all but one showed amounts of benzol vapor greater than 75 parts per million, which is the greatest concentration considered safe for all-day exposure, while the three operations equipped with local exhaust systems showed less than 50 parts per million. It is apparent that such blower systems, which satisfactorily eliminate the benzol hazard, should be installed whenever it is necessary to use benzol cement in any quantity.

A relationship between quantity of benzol used and probable exposure may be obtained from these data, from which it is apparent that when much more than one gallon per day is used there may be exposure to concentrations above the allowable limit. In the case of the white cleaner and uniformer, of which about one gallon per day was used by a group of six workers, an average concentration of 35 parts per million was found, indicating satisfactory conditions. It is not shown conclusively which of the cementing processes are most hazardous, but the single test made on channel cementing indicated a lower exposure than was found for any other cementing operation carried out without exhaust protection.

Benzol was found in a black stain used in small amounts, and it was used for cleaning a cementing machine in one plant.

The advantages of benzol cements over cements in which naphtha is the solvent are disputed. Benzol is a better rubber solvent than naphtha and makes a faster-drying cement. While naphtha breasting cements are said to be as efficient as the benzol cements, the latter are often preferred for attaching rubber to leather. Thus the crepe sole cements and rubber heel cements frequently contain benzol. Four of the plants visited discontinued the use of benzol as a result of the survey, while one installed a blower system. Three plants are known to have given up benzol cements for economic reasons.

It was found that the benzol labeling law was usually obeyed by the firms supplying products containing benzol to the shoe manufacturers. The small containers from which the cements or other materials were used were, however, frequently not labeled. Copies of the benzol labeling law were sent to all plants not observing it.

Other Solvents.—Air analyses were also made in the vicinity of processes employing other solvents, notably acetone, ethyl acetate, ether and naphtha. The results of the most important of these are shown in Table V.

The greatest exposure to solvent vapors in the processes here enumerated occurred in softening the pyroxlyn cement used in attaching soles to uppers in cemented shoes. The highest total vapor concentration found for this operation was 465 p.p.m., consisting chiefly of naphtha and ether vapors. The concentration of ether vapor found in the treeing operation, 90 p.p.m., was believed to be lower than that frequently encountered.

Table V.—Air Analyses for Other Solvents

Process	Number of Tests	Persons Exposed		Average Concentration of Vapor Found (Parts per million)				
		Male	Female	Acetone	Ethyl Acetate	Ether	Naphtha	Total
Bleaching Soles . . .	2	0	3	22	–	–	–	22
Pasting Underlays . .	1	0	3	2.5	45	–	–	48
Softening Celluloid Box Toes	2	5	0	45	45	–	–	90
Softening Pyroxylin Cement	4	9	0	45	35	Present	Present	335
Cementing Lasting Allowance	7	2	10	–	55	–	–	55
Treeing	2	19	0	–	–	90	–	90
Cementing Channels . .	1	1	0	–	–	–	95	95

Tests for carbon monoxide in the vicinity of edge setting, heel burnishing and box toe softening machines showed negligible concentrations of this gas.

Other toxic solvents found in relatively small quantities were carbon tetrachloride, carbon bisulfide and methanol. Carbon tetrachloride was used by eight factories, while three reported having had unfavorable experience with it.

A summary of the potential hazards found, and the departments in which they occurred, is shown in Table VI.

TABLE VI.—HEALTH HAZARDS IN THE MANUFACTURE OF SHOES

M-Found in men's shoe factories. W-Found in women's shoe factories. Small letters indicate isolated cases. DEPARTMENT	Acetone	Ammonia	Amyl Acetate	Benzol	Carbon Bisulfide	Carbon Tetrachloride	Dichlorbenzene	Ether	Ethyl Acetate	Ethyl Alcohol	Methanol	Methyl Acetate	Naphtha, Gasoline, etc.	Oxalic Acid	Toluol	Trichlorethylene	Carbon Monoxide	Dust, inorganic	Dust, leather	TOTALS M	TOTALS W
Cutting																		MW		1	1
Stitching . . .	W	MW							W				MW							2	4
Stockfitting . .	MW	MW	m	M	m	m			MW	W	MW	W	MW		MW	m				11	8
Lasting . . .	MW	MW		M					MW				MW					M		6	4
Making . . .	MW	MW		MW		M		W	MW			W	MW			MW		M	W	8	9
Finishing . . .	MW	W		M			m		MW		mW	M	W	MW	W		MW	M	MW	10	9
Packing . . .	MW	MW		MW	MW	MW		MW	MW	MW	MW	M	MW	W	W			MW		12	13
Totals . . .	5 /6	5 /6	1 /0	5 /2	2 /1	3 /1	1 /0	1 /2	5 /6	1 /2	3 /3	2 /2	5 /6	1 /2	1 /3	2 /1	1 /1	5 /2	1 /2	50	48